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## MEMORANDUM DESCRIBING ROOT STUDIES AT THE HACKAMORE FIELD LABORATORY IN THE SUMMER OF 1940

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Forest Insect Laboratory
Berkeley, California
January 3, 1941

# MEMORANDUM DESCRIBING ROOT STUDIES AT THE MACKAMORE FIELD LABORATORY IN THE SUMMER OF 1940

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# MEMORANDUM DESCRIBING ROOT STUDIES AT THE HACKAMORE FIELD LABORATORY IN THE SUMMER OF 1940

## INTRODUCTION

During the course of the field work at the Hackamore Laboratory in May and June, 1940, the root systems of several pine trees were partially uncovered to allow examination of their condition. This work was performed in conjunction with the surveys being made at the time of the Matsucoccus and Melampohila californica Van Dyke populations on Risk 1 and Risk 4 trees in the Hackamore area. It was intended to examine a fairly large series of root systems of such Risk 1 and Risk 4 trees for the purpose of correlating the information gained from this source with that supplied by the examinations made for scales and Melampohila incipient larvae in the crowns of the trees. But the nature of the work made possible the examination of the root systems only at a very slow rate, and for this reason, coupled with early cessation of the field program at Hackamore, the examination of an extended series of root systems was not possible. Portions of the root systems of only six trees were exposed. But for these a brief description of the conditions that were observed in them will be given.

## ORGANIZATION OF THE WORK

### Location of Trees

The work was conducted on trees that were being felled by the Shaw Bertram Lumber Company in the vicinity of the Mud Lakes, Modoc County, California. The first three trees whose roots were uncovered were in an area about two miles south of the Lower Mud Lake. The remaining three trees were located perhaps five to ten chains from the southwestern shores of Lower Mud Lake itself.

### Exposing the Root Systems

The work of the root excavation was carried out with the assistance of two to four CCC enrollees who were supplied from the Hackamore CCC Camp by arrangement with the Modoc Forest Service Office. The enrollees removed the soil from the root systems by the use of hand tools - picks and shovels. It was not attempted to use hydraulic methods even where water was available because of the rocky character of the soil and because of the drainage problem in the lava soil.

In exposing the root systems two procedures were followed. With the first four trees several large roots, generally four, that were near the surface were followed out from the stump for twenty to thirty feet. These four roots were considered to be a sample of the root system as a whole. For the remaining two trees the exposure of the roots was extended to include all the surface roots of each stump, these roots constituting a sample of the root system of the tree.

## Information to be Secured

It was planned to gather information on the condition of the root systems from two sources:

1. A general examination of each surface root leaving the stump and its branches to determine their apparent condition. Special attention would be given to the soundness of the roots, the numbers of living and dead branches, and the occurrence of pitching, dead stripe, abnormal outgrowths, lesions and other phenomena that might be pathological in character.

2. A microscopic examination of the condition of the small "feeding" roots and mycorrhizal masses that were collected and preserved in fixatives for study by a qualified plant pathologist.

# RESULTS

## Analysis of Data

Since there were only six trees examined, and these were unequally divided between Risk 1 and Risk 4 susceptibility classes, the sample seems scarcely large enough to allow an analysis leading to any definite conclusions. Data are not yet available also from the survey of the Matsucoccus populations or from microscopic examinations of the rootlets. So for the purpose of the present record, the memorandum will confine itself to giving a general characterization of the apparent condition of each tree and of its roots, as noted in the general inspection of them in the field. For this purpose the roots are divisible into two categories: (1) those roots (generally large) arising on the stump, and (2) the smaller branches of these roots, the size of which ranged from about three inches in diameter down to about ¼ inch in diameter.

## Tree Records

Tree No. 1.

Condition of crown of tree: A vigorous tree of excellent appearance, needles long, coarse, dark green, complements large, a Risk 1 tree; diameter about 32 inches, approximately a Keen 3A, Dunning 3 (tree was felled before classification, and was the only tree not belonging to the Matsucoccus series).

Melanophila infestation: No Melanophila californica Van Dyke incipients found in bole of tree.

Site condition: The tree was growing on flat ground, the ground very rocky beneath the surface.

Root examination: Four large roots, two on each side of the tree stump, were exposed for a distance of about 35 feet from the stump. The roots maintained a depth of about 12 inches below the surface of the ground. The four large roots were sound and green throughout the length exposed. Their smaller branches, however, often were dead, either entirely or at a short distance from the large roots. Several small branches about ½ inch in diameter appeared to have been chewed off.

Tree No. 2.

Condition of crown of tree: A vigorous tree, of excellent appearance, needles long, coarse, dark green, needle complements large, a Risk 1 tree; diameter 26 inches, length 108 feet, Keen 3B, Dunning 3.

Melanophila infestation: No Melanophila californica incipient larvae in the crown of the tree.

Site condition: The tree was growing on flat ground, ground very rocky beneath the surface.

Root examination: Examination of the root system was interrupted by logging operations when but two roots had been uncovered. These roots were sound and green throughout their length. The smaller branches, however, were frequently dead entirely or at a short distance from the larger roots.

Tree No. 3.

Condition of crown of tree: A vigorous tree, of excellent appearance, needles long, coarse, dark green, needle complements large, a Risk 1 tree; diameter 30 inches, length 102 feet, Keen 3A, Dunning 3.

Melanophila infestation: No Melanophila californica incipient larvae were found in the crown.

Site condition: The tree was growing on ground with a slight slope; ground less rocky than in the cases of the two previous trees.

Root examination: Four roots, two on each side of the stump, were uncovered. These roots showed a condition of health similar to tree Nos. 1 and 2. The large roots were sound and green in the distance of about 30 feet over which they were exposed. Smaller branches of the roots were often dead entirely, or at a greater or less distance from the larger roots.

Tree No. 4.

Condition of crown of tree: A vigorous tree, of excellent appearance, needles long, coarse, dark green, needle complements large, a Risk 1 tree; diameter 32 inches, length 90 feet, Keen 3B, Dunning 3.

Melanophila infestation: No Melanophila californica incipient larvae were found in the crown.

Site condition: The tree was growing on flat ground about seven chains from the shore of Lower Mud Lake; soil not very rocky.

Root examination: Four roots were exposed. These were lettered consecutively for purposes of notation of root conditions of each:

Root A - gave off ten branch roots, of which six were alive and four were dead.

Root B - gave off ten branch roots that were alive at their points of origin. Eight of these were dead a few inches out from the large root. Root B had numerous very small dead branches (about ¼ inch in diameter) along it, and had a dead strip for about six feet along one side.

Root C - had three branches, all living, but the second branch had a number of dead smaller branches.

Root d - Had seven living branches and three dead branches.

This tree, as in the other three trees, shows numerous small dead branches along the large roots that were examined. The large roots were, as in the other trees, close to the surface of the ground - eight to fourteen inches beneath the surface for the most part. They were exposed out from the trunk for about thirty feet.

Tree No. 5.

Condition of crown of tree: A very healthy appearing tree, of excellent appearance, needles long, coarse, but light green, complements large, a Risk 1 tree, light needles may have been related to the heavy cone crop; diameter 34 inches, height 78 feet, Keen 4A, Dunning 5.

Melanophila infestation: No Melanophila californica incipient larvae found in crown.

Site condition: Tree growing on flat ground about ten chains from the shore of Lower Mud Lake; soil not very rocky.

Root examination: All of the large surface roots were exposed to a distance of thirty or more feet from the tree, and were lettered consecutively in the notes:

Root A - was decayed and dead about ten feet from stump: Root A had two living branches and two dead branches.

Root B - sound and green, with three living branches and one dead branch.

Root C - sound and green, with seven living branches and one dead branch.
Root D - dead about 30 feet from the stump. The root had fourteen living branches.
Root E - alive, and all branches alive.
Root F - completely dead from stump outward.
Root G - alive, and root had six living branches.
Root H - alive, with one dead branch.

This tree had a number of dead roots.

Tree No. 6.

Condition of crown of tree: An unhealthy looking tree, needles medium or less in length, complements small, color varying from dark to light green, numerous flags below old topkill, and others throughout crown, twig and branch injury severe, a 16 percent old topkill, a Risk 4 tree; diameter 34 inches, length 96 feet, Keen 4B, Dunning 5.

Melanophila infestation: Large numbers of Melanophila californica incipient larvae throughout length of living bole.

Site condition: Tree growing on flat ground about five chains from shore of Lower Mud Lake; soil not very rocky.

Root examination: All of the surface roots were uncovered out to a distance ranging from 25 to 30 feet from the stump. Their depth in the soil was about the same as in the cases of the other trees - from 8 to 14 inches below the soil surface. The roots were lettered consecutively, as in tree Nos. 4 and 5.

Root A - had six living branches and three entirely dead branches, but all of Root A and its branches were dead at the ends at some distance from their origin.
Root B - with one living branch, the large root dead distally.
Root C - with four living branches and three dead branches; the large root dead distally.
Root D - had one living branch; the large root dead distally.
Root E - with one living branch, the large root dead distally.
Root F - with one living branch, the large root dead distally.
Root G - Letter left out of series, next root is
Root H - unbranched, dead distally.
Root I - green at stump, but completely decayed a short distance distally.
Root J - five branched, with two living and three dead branches. All roots are decayed at the distal ends, and appeared to have been chewed off.
Root K - with three branches, all living; the large root dead distally.
Root L - three branched, and whole root dead within 12 inches of the stump.

Root M - the root had eight living branches and three dead branches; the large root was dead distally.
Root N - unbranched, and entirely dead.
Root O - a small root, about 3/8 of an inch in diameter; root living, with good mycorrhizal masses on its branches.
Root P - had six living branches, one of these becoming dead distally; the large root dead distally; the large root with a large, pitchy cancerous growth on one side about six feet from stump. The root had a pitchy strip-kill along one side beyond the cancerous growth.

Of the roots of Tree No. 6 that were examined, only Root O was fully alive. All other large roots were dead either at the stump or at some distance from the stump. The roots were bumpy, pitchy, and some appeared to have been chewed off, some of the chewed-off roots having healed over later at the ends. The root system of this tree was definitely in the poorest condition of any of the six that were examined.

## REMARKS

From these notes it appears that even in the root systems of Risk 1 trees there were quite a few dead roots. Such a condition may be a normal one. The root system of the one Risk 4 tree, however, was in noticeably poorer condition. These data may be compared with, and added to, the data obtained in previous examinations of root systems of five other trees (Salman 1939)(West 1939). The records of these trees were as follows:

Tree No. 1. A windfall, low risk, with an extensive, much branched, apparently healthy root system.

Tree No. 2. A windfall adjacent to No. 1, a high risk tree with heavy, unsuccessful attacks of Melanophila californica. The tree possessed an abnormal and reduced root system.

Tree No. 3. A high risk tree (Risk 4), possessing an apparently healthy, extensive, much branched root system, there being only an occasional dead rootlet.

Tree No. 4. A high risk tree (Risk 4), that had died with an attack of Dendroctonus brevicomis following three successive years of progressive topkilling associated with Melanophila infestations. The root system of this tree appeared to be well developed and in healthy condition.

Tree No. 5. A high risk tree, adjacent to No. 4, infested in the upper bole with Melanophila californica incipient larvae and attacked successfully by Dendroctonus brevicomis in conjunction with the attack on Tree No. 4. The root system appeared to be well developed and in healthy condition.

Thus in these last five trees, the one low risk tree had a well-developed, apparently healthy root system. Of the four high risk trees, three had extensive and apparently healthy root systems, the fourth, however, having a root system that was much reduced and apparently abnormal.

Adding these five cases to the six of the current study, there are six low risk trees, the root systems of all of which were considered to be in good condition. Of the five high risk trees, the root systems of three apparently were in good condition, the root systems of the remaining two, however, appearing to be in poor condition.

## PROBLEMS ASSOCIATED WITH THE WORK

The root work presented certain difficulties. These are recorded here in the event that they may be a useful reference if further work along these lines should be undertaken.

### Methods of Excavation

West (1939, page 71) discusses the difficulties attendant on such work, and with the use of a hydraulic method. In the present work the use of picks and shovels was unsatisfactory also. With these tools it was not possible to excavate to deeper portions of the root systems because of the large rocks and boulders that were frequently encountered beneath the soil surface. Likewise, these tools were not very satisfactory when the finer networks of roots and the mycorrhizal masses were being traced and separated from the soil. For such work it is believed that better results might be obtained by combining the use, when a supply of water is readily available, of proper portable hydraulic force pumps and pumps for exhausting the excess water, with the use of picks, shovels and small hand tools such as trowels and small hand picks. With such equipment it probably would be possible to follow out the ramifications of the root systems to their very small divisions.

### Labor

In the performance of the work in 1940 it was necessary to place much reliance upon the CCC enrollees while the Bureau personnel carried out phases of other studies in the same area. The enrollees were conscientious, willing and dilligent in their work, but it was found that they were not well fitted by educational training and ability to perform the precise work that was required to expose the roots in an intact condition. It is believed that further studies of the root systems may be best accomplished when the work is performed under the constant direction and attention of one man assisted by a crew of men possessing proper educational background as well as sufficient experience in the performance of the hard labor such work entails.

## Sampling Methods and Methods of Examination

A third problem presented by the work was the question of the methods that would give a proper sampling and examination of the root systems. More information was needed on the questions:

1. How much of the root system should be examined in order to allow an estimate of its condition?
2. What levels of the root system should be examined?
3. What organic parts should be examined for evidence of the injury - the larger roots, the smaller roots, or the mycorrhizal masses, or all of these?
4. Is there a preferred season for making such root studies?

## SUMMARY

This memorandum on the study may be briefly summarized:

1. The root systems of six trees were partially uncovered and their conditions noted during May and June, 1940, in the vicinity of the Mud Lakes, Modoc County, California.
2. These trees were of the same series of Risk 1 and Risk 4 trees that were examined for the Matsucoccus and Melanophila population surveys (except No. 1).
3. Five of the trees were Risk 1 and one was Risk 4.
4. The root systems of the five Risk 1 trees showed numerous dead branches of larger roots.
5. The root system of the Risk 4 tree showed many more dead large roots and branches than the Risk 1 trees, and was considered to be in a poorer condition than the root systems of those trees.
6. The records of the root systems of five other trees that had been previously examined were presented for comparison. The one low risk tree and three or the four high risk trees were believed to have good root systems.
7. Problems attendant on the root work were mentioned: the combined use of pumps, shovels, picks and small handtools is recommended; skilled, well-trained labor is needed; proper methods of sampling root systems and of determining the condition of the roots need further study.

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